PARAMETER INVESTIGATION OF PASSIVE TO SEMI ACTIVE COOLING TECHNIQUE FOR HOUSE IN TROPICAL CLIMATE

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Thesis submitted in fulfillment of the requirements
for the award of the degree of
Master of Science

Faculty of Manufacturing & Mechatronic Engineering Technology

UNIVERSITI MALAYSIA PAHANG

JUNE 2023

ACKNOWLEDGEMENTS

I want to express my gratitude to those who were by my side during completing this research. First and foremost, grateful to the Greatest for ease my journey everything from the moment that I decided to follow your path even though I almost give up.

I am a lucky person to have the greatest supervisor that I ever had. I would like to express my sincere gratitude to Dr. Zubair bin Khalil for his patience, motivation, responded to my questions and queries and correcting my silly mistakes. Thank you for giving me the opportunity to teach his class and for inspiring me to pursue a career in academic. I am proud to finish this research under his supervision.

Special thanks to all Imams Lab members for their kindness during my stay at the lab. I'd like to convey my gratitude to my family. Thank you so much to everyone.

Lastly I want to thank me, for believing in me, doing all this hard work, and endure all pain by myself.

ABSTRAK

Iklim Malaysia boleh digambarkan sebagai panas dan lembap sepanjang tahun. Oleh kerana penggunaan penghawa dingin secara meluas untuk mengatasi pemanasan melampau, yang menyumbang kepada pemanasan global, penggunaan tenaga di bangunan kediaman telah menjadi kebimbangan utama. Kaedah alternatif, seperti penyejukan pasif, telah diterokai sebagai penyelesaian kepada isu ini. Penggunaan lapisan rumah berganda (DSF) sebagai ciri canggih yang boleh mengurangkan penggunaan tenaga dan meningkatkan keselesaan terma. Untuk menentukan keberkesanannya dalam menurunkan suhu, tiga parameter telah dipertimbangkan. Dalam DSF, bilangan salur masuk, bilangan jurang dan jenis aliran telah disiasat di bumbung, dinding dan lantai. Eksperimen dijalankan di dalam (persekitaran terkawal) dan kawasan luar. Eksperimen dalaman dijalankan di bahagian ujian di mana suhu ambien dikawal. Semua model rumah diletakkan di dalam bahagian ujian untuk menganalisis kadar pemindahan haba dan suhu di dalam rumah untuk mod pemanasan dan penyejukan. Bahagian ujian telah ditebat dengan menggunakan papan polistirena dan buih semburan. Satu sensor diletakkan di dalam setiap rumah dan 10 sensor dipasang untuk bahagian ujian. Dua pemanas digunakan untuk memanaskan suhu melebihi 50 ℃. Kipas telah dihidupkan semasa mod penyejukan untuk mendorong aliran. Seterusnya eksperimen dijalankan di kawasan luar yang luas dengan menggunakan cuaca sebenar terutamanya di Pekan, Pahang. Bacaan suhu, halaju, kelembapan direkodkan pada jam 10:00 pagi hingga 3:00 petang. Kemudian, kepentingan parameter dianalisis dengan menggunakan Reka Bentuk Eksperimen. Kaedah satu faktor pada masa digunakan untuk menilai kepentingan jenis parameter aliran. Seterusnya tiga parameter utama, bilangan masuk, bilangan jurang dan jenis aliran telah mengesahkan kepentingannya dengan menggunakan reka bentuk faktorial 2 peringkat berdasarkan analisis varians dan carta pareto. Kadar pemindahan haba dianalisis menggunakan nombor Fourier dan suhu tidak berdimensi untuk menentukan mod pemanasan dan penyejukan reka bentuk terbaik. Menurut keputusan menunjukkan bahawa DSF membawa kepada pengurangan suhu dalaman. Rumah dengan 0 salur masuk dan 3 jurang mempunyai kadar pemindahan haba yang paling rendah. Pengaliran dalam mod pemanasan menyaksikan peningkatan suhu yang perlahan. Reka bentuk optimum untuk melepaskan haba dan menyejukkan rumah secara perolakan termasuk rumah dengan 3 salur masuk dan 3 celah. Rumah dengan 3 salur masuk dan 3 jurang adalah parameter utama. Kadar penyejukan maksimum ialah 15.12 ℃/j yang menyumbang kepada perbezaan suhu melebihi 10 ℃ dengan halaju udara minimum 2m/s. Perbezaan kelembapan yang diperlukan untuk menyokong perbezaan suhu adalah dalam julat 14% hingga 20%. Adalah sangat disyorkan untuk mereka bentuk rumah eko yang menggunakan teknik penyejukan pasif kepada separa aktif untuk mengurangkan suhu di bangunan kediaman. DSF merupakan salah satu teknik pasif dan semi aktif yang mempunyai keupayaan menurunkan suhu tanpa menggunakan sistem penghawa dingin.

ABSTRACT

Malaysia's climate can be described as hot and humid throughout the year. Because of the extensive use of air conditioners to counter overheating, which contributes to global warming, energy consumption in residential buildings has become a major concern. Alternative methods, such as passive cooling, were explored as a solution to this issue. The usage of a double skin façade (DSF) as advanced feature that can reduce energy consumption and increase thermal comfort. To determine their effectiveness in lowering temperature, three parameters were considered. Within DSF, the number of inlets, number of gaps, and types of flow were investigated at the roof, wall, and floor. The experiment were conducted in indoor (controlled environment) and outdoor area. The indoor experiment was conducted in a test section where the ambient temperature was controlled. All model of house were placed inside the test section to analyze heat transfer rate and temperature in the house for heating and cooling mode. The test section was insulated by using polystyrene board and spray foam. One sensor was placed inside each of the house and 10 sensor were installed for test section. Two heater were used to heated up temperature above 50℃. A fan was turned on during cooling mode to induce flow. Next the experiment was conducted in spacious outdoor area by using actual weather mainly in Pekan, Pahang. The reading of temperature, velocity, humidity were recorded 10:00 am until 3:00 pm. Then, the significance of parameters was analyze by using Design of Experiment. One factor at time method was used to evaluate significance of parameter types of flow. Next three main parameter, number of inlet, number of gap and types of flow were validate their significance by using 2 level factorial design based on analysis of variance and pareto chart. Heat transfer rate was analyze using Fourier number and dimensionless temperature to determine best design heating and cooling mode. According to results show that the DSF leads to a reduction in indoor temperature. The house with 0 inlet and 3 gap had the lowest rate of heat transfer. Conduction in the heating mode was moderate increase in temperature. The optimum design for releasing heat and cooling the house by convection included house with 3 inlets and 3 gaps. The house with 3 inlets and 3 gaps was a major parameters. Maximum cooling rate was 15.12 ℃/h that contributed to the temperature difference over 10 ℃ with a minimum air velocity of 2m/s. Humidity difference that required to support the temperature difference was in range 14% to 20%. It was highly recommended that to design an eco house that apply passive to semi active cooling technique to reduce temperature in residential building. DSF was one of passive and semi active technique that have the ability of reduce temperature without using air conditioning system.

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